CLAIMS

1. A reaction vessel that is elongated substantially along a substantially vertical axis, comprising at least two stages in the vertical direction, in which at least one endothermic or exothermic catalytic reaction is carried out, comprising:

- at least one catalytic reaction zone (12a, 12b) per stage (6, 7) and extending substantially along the axis of the vessel;
- means (2) for introducing at least one reaction fluid to a stage adapted for substantially transverse fluid movement over substantially the whole vertical extent of the reaction zone;
- means for introducing catalyst into the reaction zone and means for extracting catalyst from the reaction zone;
- at least one means (5a) for heat exchange with the reaction fluids, located inside the vessel between two successive reaction zones;
- means (6) for transporting reaction fluids from one stage to another connected firstly to a heat exchange means and secondly to the reaction zone,;
- means for recovering reaction fluids downstream of the last stage;

the thickness of each reaction zone being determined to limit the variation in temperature in said zone and the heat exchange means being adapted to adjust the temperature of the reaction fluids entering the reaction zone to a level substantially at most equal to that of the temperature of the reaction fluids entering the preceding zone.

2. A vessel according to claim 1, in which the catalyst is in the form of fixed beds.

3. A vessel according to claim 1, in which the catalyst is in the form of a moving bed, with substantially gravitational flow, the reaction zone or zones of one stage being connected to that/those of a lower stage via at least one passage with cross section S1 that is reduced with respect to the cross section S2 of the reaction zone, the reaction zone or zones of the first stage comprising means for introducing catalyst and the reaction zone or zones of the final stage comprising catalyst extraction means, said extraction means comprising a means for adjusting and controlling the rate of catalyst flow.

4. A reaction vessel according to claim 3, characterized in that the catalyst and reaction fluids move in a generally co-current motion along the axis of the vessel.

5. A reaction vessel according to any one of claims 1 to 4, comprising at least two stages (6, 7) and at least two reaction zones (12a, 12d) per stage.

6. A reaction vessel according to any one of claims 1 to 5, comprising three to twelve reaction zones, limits included.

7. A reaction vessel according to any one of claims 1 to 6, characterized in that at least one of the reaction zones has a substantially planar cross section.

8. A reaction vessel according to any one of claims 1 to 6, characterized in that at least one of the reaction zones has a substantially annular cross section.

9. A reaction vessel according to any one of claims 1 to 6, characterized in that at least one of the reaction zones has a substantially elliptical cross section.

10. A reaction vessel according to any one of claims 1 to 9 comprising, downstream of the exchange means in the direction of motion of the reaction fluids, at least one means (304, 804, 805) encouraging mixing of the reaction fluids from the exchange means prior to their introduction into the reaction zone located downstream of said exchange means.

11. A reaction vessel according to any one of claims 1 to 10, characterized in that the means for transporting reaction fluids from one stage to the lower stage are disposed substantially in the proximity of the central axis of the vessel.

12. A reaction vessel according to any one of claims 1 to 11, characterized in that a means (616) placed substantially at the centre of at least one stage separates the reaction fluids into a plurality of streams, each stream then separately traversing a succession of reaction zones (606, 605, 604; 601, 602, 603) and heat exchange means (613, 614, 615; 611, 612, 615) within that stage.

13. A reaction vessel according to any one of claims 1 to 12, in which at least one of the heat exchange means comprises a series of finned tubes, the reaction fluids moving externally of said tubes.

14. A reaction vessel according to any one of claims 1 to 13, in which at least a portion of said heat exchange means is disposed between two successive stages.

15. Use of a reaction vessel according to any one of claims 1 to 14 for dehydrogenating linear paraffins containing between about 3 and about 20 carbon atoms.

16. Use of a reaction vessel according to any one of claims 1 to 14 in a process for producing aromatic compounds at least one substituent on the aromatic cycle of which is a linear aliphatic chain, in general an alkyl chain, containing about 3 to about 20 carbon atoms, and wherein one of the steps is the formation of mono-olefinic compounds.

17. A process for converting a hydrocarbon feed employing a reaction vessel comprising at least two catalytic reaction stages according to any one of claims 1 to 14, characterized in that the feed is moved substantially transversely in at least one reaction zone of a first stage of the vessel at a suitable temperature, a reaction fluid is recovered at the outlet from the reaction zone, heat is exchanged between the reaction fluid and a heat exchange fluid in at least one heat exchange zone located downstream of the reaction zone and inside the vessel and after heat exchange, the reaction fluid is moved into at least one reaction zone of a subsequent stage, a conversion effluent being recovered from the final stage of the reaction vessel, the residence time of the catalyst in each reaction zone and the hourly space velocity of the feed being determined to limit the temperature variation in each reaction zone and heat exchange being controlled to adjust the temperature of the reaction fluid entering the reaction zone to a level substantially at most equal to the temperature of the reaction fluid entering the preceding zone.

18. Process according to claim 17, in which each reaction zone comprises at least one fixed catalyst bed.

19. A process according to claim 17, in which the reaction zone of one stage communicates with the reaction zone of a subsequent stage, the catalyst flow between the two reaction zones being in moving bed mode and the flow of reaction fluid crossing that of the catalyst.

20. A process according to claim 17, in which each reaction zone is operated in fixed bed mode during a major portion of the time and in moving bed mode during a minor portion of the time to carry out periodic extraction of a portion of the catalyst.

21. A process according to any one of claims 17 to 20, in which the hourly space velocity, defined as the ratio of the mass flow rate of feed or reaction fluid to the mass of catalyst contained in the reaction zone, is between 1 and 100 h^{-1}, preferably between 5 and 30 h^{-1}.

22. A process according to any one of claims 17 to 21, in which the residence time for the feed in each reaction zone is in the range 0.01 s to 1 s, preferably in the range 0.03 to 0.1 s.

23. A process according to any one of claims 17, 19 to 22, in which the catalyst moves in each reaction zone at a speed in the range 1 cm/h to 20 cm/h, preferably in the range 2 cm/h to 10 cm/h.

24. A process according to any one of claims 17 to 23, in which the variation in temperature in one reaction zone is limited to a value in the range 2°C to 50°C, preferably to a value in the range 5°C to 15°C.

25. A process according to any one of claims 17 to 24, in which a portion of the catalyst is extracted from the outlet from the vessel, regenerated in at least one regeneration zone located outside the vessel and re-introduced into the reaction zone inside the vessel.